the hydrochinon may be continued for thirty minutes, or until the plate fogs. As far as the trials go, the glycin is slightly better than the hydrochinon.

The first negative obtained at this observatory, showing the Zodiacal Light, was on March 10, 1899. Many different lenses were tested, and a number of satisfactory negatives were obtained, of which one of the best was of the eastern cone, on October 7, 1899. This was reproduced in *Popular Astronomy*, No. 74, April, 1900. But the engraving did not by any means equal the photographic print. And, besides that, the original exposures before the present year were all made by hand-following. This tedious work was done nearly always by Mr. W. A. COGSHALL.

LOWELL OBSERVATORY,
FLAGSTAFF, ARIZONA, March 11, 1901.

PHOTOGRAPHIC OBSERVATIONS OF COMET II, 1900 (BORRELLY–BROOKS).

BY H. K. PALMER.

This comet was discovered by BORRELLY, at Marseilles, and independently by BROOKS, at Geneva, N. Y., on July 23, 1900. At the time of its discovery it had a bright stellar nucleus of about the 6½ magnitude. It was first observed at the Lick Observatory on July 24th, and was found to be bright enough to warrant a series of photographs. Accordingly, on the 25th, this series was begun, and was continued until August 4th, when the Moon interfered. By the time the Moon was out of the way the comet had become so faint that further photographic observations were impossible.

On July 25th, the comet was photographed with the Crocker telescope, but on all succeeding nights, except August 4th, with a Willard lens attached to the five-inch Floyd telescope. The latter was used as a guiding telescope. Both the Crocker and the Willard lenses have apertures of six inches. The focal length of the Crocker is 30.82 inches, while that of the Willard lens is only 25.99 inches. On the photograph taken with the Crocker telescope, 1 degree = 0.538 inch; and on those taken with the Willard lens, 1 degree = 0.454 inch. The photographs

July 25. Exp. 1^h 10^m.

July 27. Exp. 2^h 15^m.

July 29. Exp. 2^h 29^m.

July 31. Exp. 2^h 6^m.

Aug. 2. Exp. 3^h 2^m.

Aug. 3. Exp. 3^h 9^m.

COMET 1900 II. (BORRELLY–BROOKS).

shown here have all been enlarged to the uniform scale of 1 degree = 0.75 inch.

The usual method of guiding these telescopes is to keep the head of the comet on the intersection of two coarse, dark cross-wires in the focus of the guiding telescope. The nucleus of this comet was so small that it was completely hidden by the wires, leaving nothing but the diffuse head to guide upon. After three nights' trial of this method, double wires were substituted for the single wires, and the nucleus was kept inside the square formed by their intersections. This kept the nucleus in sight all the time. The square was very little larger than the nucleus. This method required more careful watching than the other, as there were four intersections for the nucleus to hide behind instead of one; and when it disappeared some time was required to find it. So long as the nucleus was kept in sight within the square, this method gave better results than the other, as can be seen by comparing the star-trails on the photographs taken on July 25th and 27th with those taken later.

On July 25th, with an exposure of only $1^h\ 10^m$, the tail could be traced for about four degrees. It was very slender and straight, but so faint that less than half of it can be seen on the accompanying photograph. With an exposure of six minutes on the same night, the tail appeared to be only half a degree long. On the plate of July 26th the tail was but forty minutes long, and was very faint, except within fifteen minutes of the head. The long, slender parts seen on the night before had disappeared, although the exposure was of $1^h\ 37^m$ duration. On the same night Mr. CRAWFORD secured a photograph with the Crocker telescope with an exposure of about two hours, which showed the same short tail. That night the tail seemed to fork about twenty minutes from the head. The same phenomenon was noticed on July 27th, whereas the plates taken after that showed the tail to be fan-shaped, as though the space between the forks had been filled in. On July 29th and August 3d the tail was fan-shaped for only half its length, the outer half being straight and slender. In both cases this extension was very faint — too faint to show on any of the accompanying reproductions. The length of the tail varied irregularly, not being entirely dependent upon the length of the exposure, as is shown in the following table. In this the first column gives the date of the exposure, the second the length of the exposure, and the third the length of the tail.

PHOTOGRAPHS OF COMET II, 1900, (BORRELLY–BROOKS).

Date.	Exposure.	Length of Tail	Position-Angle. Tail.	Radius-Vector.	T—R.
July 25	$1^h\ 10^m$	4°	245°	253°	— 8°
25	6	30′	...	...	...
26	1 37	40	236	254	— 18
..	....	..	246	254	— 8
27	2 15	70	240	254	— 14
28	2 38	80	245	255	— 10
29	2 29	80	238	255	— 17
30	2 47	60	242	256	— 14
31	2 6	90	247	257	— 10
Aug. 1	3 10	60	244	257	— 13
2	3 2	40	250	258	— 8
3	3 9	120	250	258	— 8
4	57	30	...	...	...

The tail was so faint that if the air happened to be at all hazy the end of it would be obscured. This would hardly be sufficient to explain the difference between the lengths of the tail on August 2d and 3d.

On all the plates, except the second and last, the slide of the plate-holder was left out about two inches after the exposure, and the clock stopped, allowing the stars to trail on one end of the plate. The position-angle of the tail was then determined from the angle between these trails and the axis of the tail. The tail, in most cases, was so very short and ill-defined that the axis could not be determined with certainty, and consequently the position-angle was estimated to the nearest degree only. This quantity is given in column four of the table. Column five contains the computed position-angle of the radius-vector of the comet, and column six the difference between columns four and five, in the sense column four minus column five. Two values are given for the position-angle of the tail on July 26th, one for each fork. The mean of the two values of T—R is 13°,— but little greater than the mean of the whole column, which is 11°.6. While these values of T—R appear to vary a great deal, it is not much more than it is to be expected, as an examination of the accompanying photographs will show how uncertain the position of the axis of the tail is. Greater extent of tail can be seen on the negatives, but it is so faint that the extension hardly adds to the accuracy. The values of T — R have a range of only ten degrees, and all show a decided negative value, larger than the

probable error of the result; showing that the tail did not coincide with the radius-vector of the comet.

The whole head was so bright that even on the six-minute plate the nucleus has disappeared from over-exposure. An exposure of less than a minute would probably have been sufficient to show the nucleus alone.

A PRELIMINARY DETERMINATION OF THE MOTION OF THE SOLAR SYSTEM.*

By W. W. Campbell.

The first investigation undertaken with the Mills spectrograph, in May, 1895, related to the determination of the radial velocities in the system of *Saturn*.† It confirmed, in all respects, the noted results announced by Professor Keeler a few weeks earlier. Determinations of stellar velocities were now undertaken, and results of considerable accuracy were at once obtained. The observed velocities of a bright solar type star could be depended upon to fall within a range of five or six kilometers. However, it soon became apparent that the instrument contained many defects. Some of these, with their remedies, have been described in my article on "The Mills Spectrograph," in the *Journal* for October, 1898; but the large majority were purely local, and do not call for special comment. The greater part of the first year was devoted to isolating and eliminating these defects; and it was not until the summer of 1896 that results considered satisfactory for publication were secured. Added precautions taken, and improvements made in the instrument and methods, have shown corresponding and gratifying increase of accuracy from year to year.

Following the methods of observation already described in the *Journal*, two thousand spectrograms have been secured since the summer of 1896. These include: plates of the solar spectrum for determining the camera-focus and scale-values; plates of stellar spectra for determining the focus of the 36-inch objective

---

* Reprinted from the *Astrophysical Journal* for January, 1901.

† *Astrophysical Journal*, August, 1895, pp. 127–135.